

A New Species of the Land Gastropod Genus *Solaropsis* Beck, 1837 (Helicoidea: Camaenidae) from Bolivia

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Abstract. A new species from Bolivia of the neotropical genus *Solaropsis* is described and illustrated using morphological characters from the shell, reproductive, pallial, nervous, and digestive systems. The new species is compared in detail with species of the genus with known anatomy. *Solaropsis chicomendesi*, sp.nov. is distinguished on the basis of its shell aperture, sculpture, and anatomical characters, mainly those of the penial complex in the reproductive system.

INTRODUCTION

Solaropsis Beck, 1837, is a neotropical genus of land snail that typically inhabits forests. It lives on trees or under fallen tree branches on the ground and is distributed from Costa Rica to northeastern Argentina. *Solaropsis* was created by Beck (1837) and later assigned to the Camaenidae. Wurtz (1955) reviewed the anatomy of the American Camaenidae excluding *Solaropsis* from the Camaenidae. Later, Nordsieck (1986) gave familial status to *Solaropsis*, establishing the Solaropsidae. For the reasons we discuss below (see Discussion) we retain *Solaropsis* in Camaenidae and reject the taxon Solaropsidae Nordsieck.

The general knowledge of the genus is scanty, and although 44 nominal species were catalogued under this genus (Richardson, 1985), very little is known concerning its anatomy and habits. The main studies on systematics and anatomy were carried out by Von Ihering (1900, 1912); Pilsbry (1890, 1957); Weyrauch (1956); Haas (1956); Tillier (1980, 1989), among others.

The aim of this study is to describe a new species of *Solaropsis* from Bolivia, comparing the anatomy of this species with that of other species of the genus whose anatomy is known.

MATERIALS AND METHODS

Adult specimens were collected from Bolivia, Santa Cruz Department, Angel Sandoval Province, Santo Corazón (17°58'24"S, 58°48'28"W), during summer (November 1997).

The specimens were drowned in water and fixed in 96% ethanol and later transferred into 70% ethanol. Dissections were carried out under a Leica MZ6 dissection microscope, and illustrations were made with the aid of a camera lucida. Shell measurements were taken with the aid of a caliper (see Table 1). Major diameter of the shell was taken including the width of the outer lip of the peri-

stome. Minor diameter is a measurement of the shell perpendicular to the major diameter. Radula and jaw were prepared for scanning electron microscopy according to Ploeger & Breure (1977). Micrographs were obtained using a JEOL Scanning Electron Microscope 35CF. Terminology used for the descriptions of the reproductive system follows Tompa (1984); pallial, digestive and nervous systems follow Tillier (1989).

RESULTS

Class GASTROPODA

Subclass PULMONATA

Order STYLOMMATOPHORA

Superfamily HELICOIDEA

Family CAMAENIDAE Pilsbry, 1895

Genus *Solaropsis* Beck, 1837

Type species: *Solaropsis undata* (Lightfoot, 1786) = *S. pellisserpentis* (Chemnitz, 1795) = *S. cicatricata* (Beck, 1837).

Solaropsis chicomendesi Cuezco & Fernández,
sp.nov.

(Figures 1–4)

Type locality: Bolivia, Santa Cruz Department, Angel Sandoval Province, Santo Corazón, 17°58'24"S, 58°48'28"W.

Type material: Holotype is deposited in the malacological collection of Museo de Historia Natural “Noel Kempff Mercado,” Santa Cruz de la Sierra, Bolivia.

Additional paratypes (four adults) are deposited in the malacological collection of Fundación Miguel Lillo, Universidad Nacional de Tucumán, San Miguel de Tucumán, Argentina. Collection number: FML 14174.

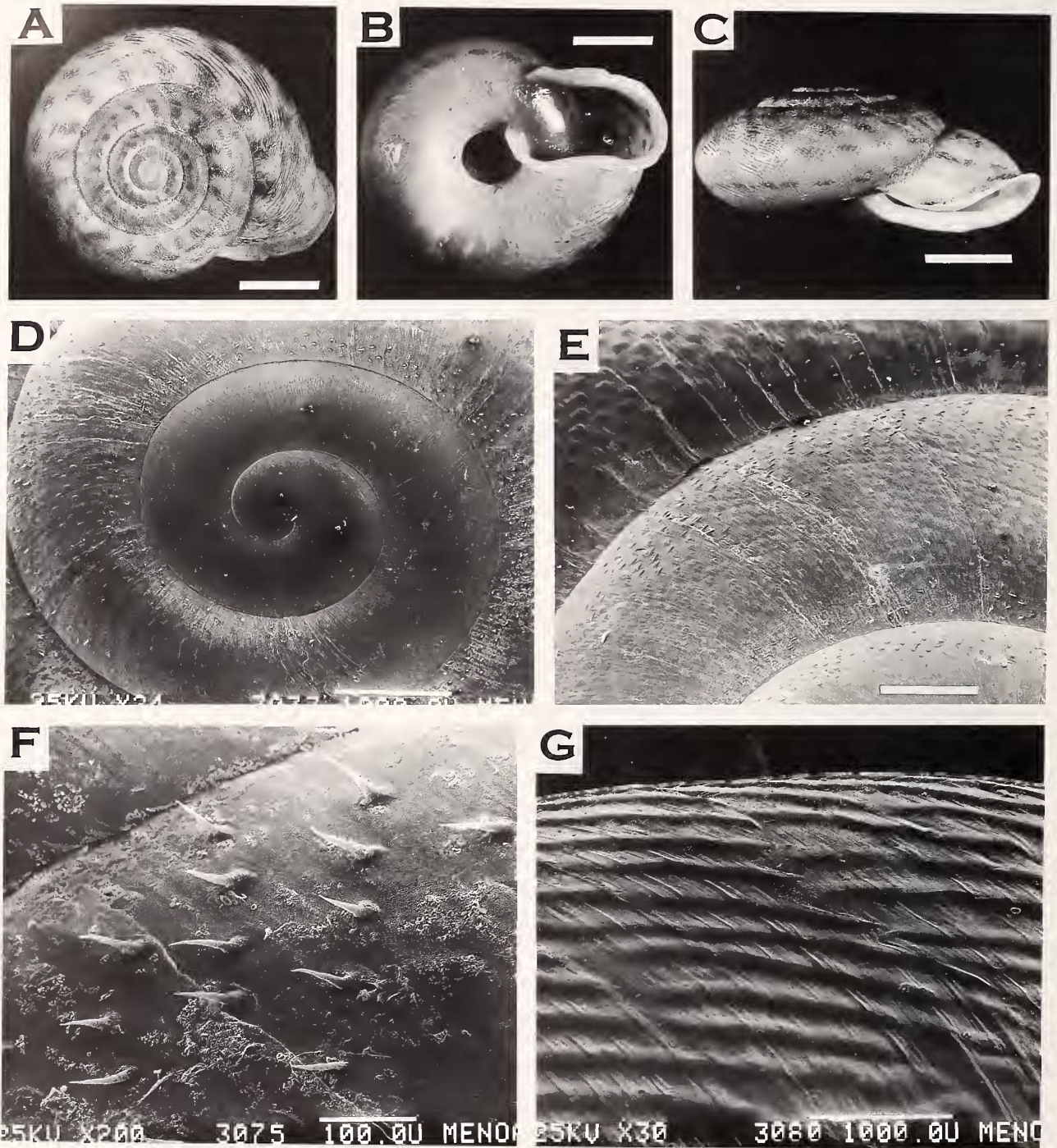


Figure 1. *Solaropsis chicomendesi* Cuezco & Fernández, sp. nov. Shell Holotype. A. Dorsal view, scale bar = 5 mm. B. Ventral view, scale bar = 5.5 mm. C. Lateral view, scale bar = 5 mm. D. Detail of the protoconch. E. Detail of the third whorl, note the position of hairs and the granules, scale bar = 1000 μ m. F. Detail of the hairs, scale bar = 100 μ m. G. Oblique ribs in body whorl, scale bar = 1000 μ m.

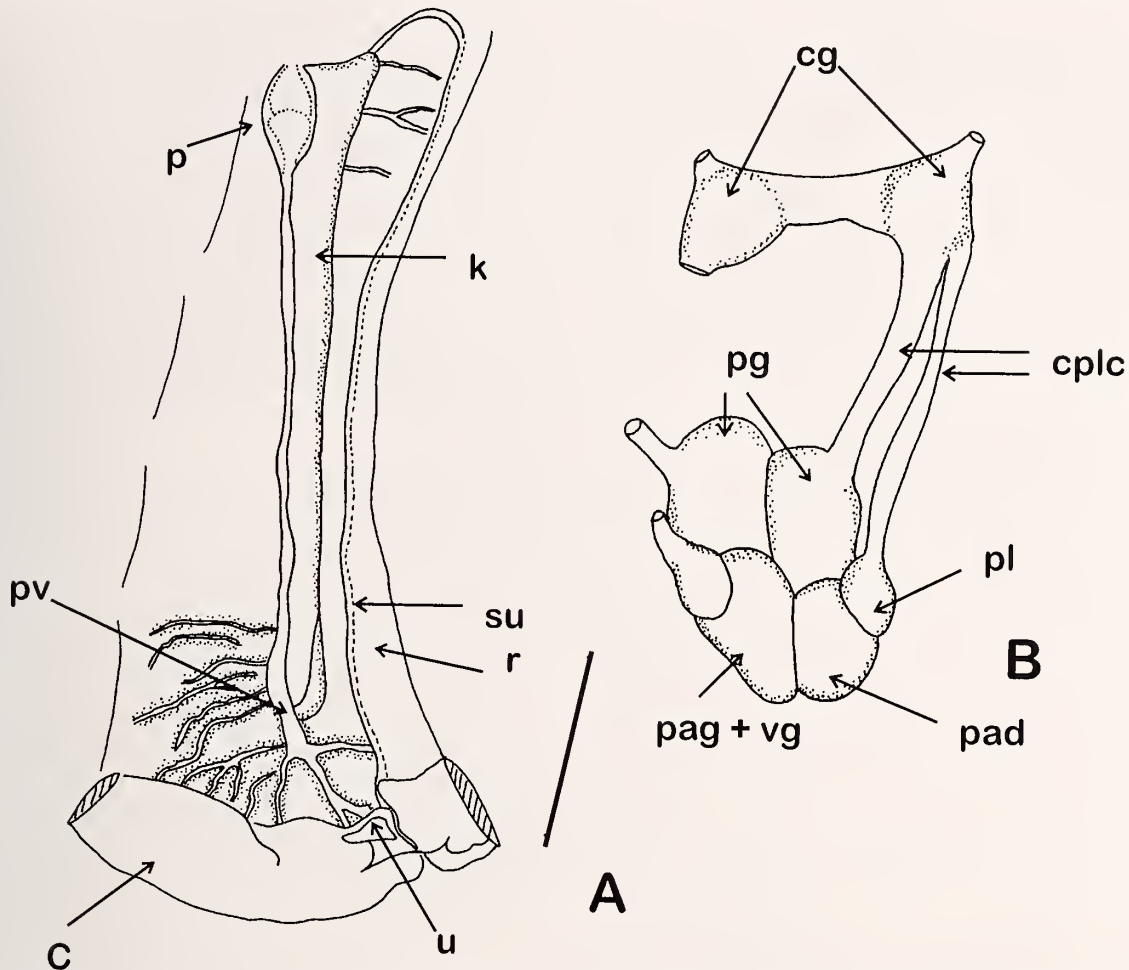


Figure 2. *Solaropsis chicomendesi* Cuezco & Fernández, sp. nov. (Paratype FML 14174). A. Pallial system, scale bar = 5 mm. B. Central nervous system, dorsal view. Abbreviations: c, mantle collar; eg, cerebral ganglia; cplc, cerebro-pleural connectives; k, kidney; p, pericardium; pad, right parietal ganglion; pag, left parietal ganglion; pg, pedal ganglia; pl, pleural ganglia; pv, pulmonary vein; r, rectum; su, secondary ureter; u, ureteric interramus; vg, visceral ganglion.

Diagnosis: Recognized by its small and fragile shell with the last whorl descending abruptly behind the aperture. Aperture ventral, subquadrangular, lips narrowly expanded. Superior lip slightly undulated. Free oviduct inserting at an angle in the vagina which is continuous with bursa copulatrix duct. Flagellum short and thick, penis with an internal pilaster for its entire length. Epiphallus reflected over penis.

External morphology of the body: Animal brownish, with two broad, dark pigmented bands that run parallel to each other from the mantle collar to the ocular tentacles; mid-dorsal groove well marked; basal sole not divided; genital orifice ogival in shape, located below right ocular tentacle.

Shell (Figure 1, Table 1): Shell dextral, helicoid, small, with spire depressed, thin, translucent, fragile; with $4\frac{1}{2}$ convex whorls, not angulated, last whorl descending

abruptly near the aperture; sutures moderately deep, hirsute, with short hairs scattered above and below sutures; umbilicus retrospective, partially overlapped by the peristome; aperture ventral, oblique, subquadrangular, peristome fragile, narrowly reflected all around, with superior lip slightly undulated; upper whorls, except the nepionic, densely granulate and on the body whorl the granules arranged in oblique ridges particularly marked behind aperture; chestnut-colored dorsally with a sutural and sub-sutural interrupted peripheral band alternating with angulated perpendicular thicker spots; below the periphery light yellowish-chestnut. Shell measurements of the holotype and paratypes in Table 1.

Pallial complex (Figure 2A): Pallial complex composed of lung, kidney, and heart; lung roof mottled with black spots especially dense close to the mantle collar; proximal extreme of lung roof extending beyond top of kidney;

Table 1

Shell measurements of holotype and paratypes of *Solaropsis chicomendesi*, sp.nov. PT = paratypes.

Shell Measurements (mm)	Holo-type	PT#1	PT#2	PT#3	PT#4	\bar{x}
Major diameter	21	20.7	21.3	20.5	19.9	20.68
Minor diameter	17.5	17.9	18.2	18	17.7	17.86
Apertural width	11.5	11.6	11.3	11.4	10	11.16
Total height	8.3	8.0	9.4	8.5	8.1	8.46

(about 2 mm), distal portion limiting with the mantle collar; kidney long and thin running parallel to secondary ureter and extending 90% of the pulmonary roof length, internally with longitudinal thin lamellae, thicker in the proximal portion of the organ; pericardium located in upper left side of kidney; main pulmonary vein runs parallel to left side of kidney and splits into three main branches before reaching mantle collar, many other minor veins running transversely to main pulmonary vein; lung floor or diaphragm membranous, translucent, and thin; secondary ureter runs parallel to rectum and closed in all its extension until reaching mantle collar; ureteric interramus triangular in shape and deeply excavated.

Reproductive system (Figure 3): Hermaphroditic gonad (ovotestis) (Figure 3C) consisting of multiple round acini bearing dark points of pigmentation, embedded in digestive gland, thin ducts of acini converging into hermaphroditic duct, which runs along columellar side; initial portion of hermaphroditic duct slender, central portion swollen, in zigzag, forming vesicula seminalis; fertilization pouch-spermathecal complex (FPSC) not evident outside albumen gland, last portion of hermaphroditic duct inserting directly into distal portion of albumen gland, this organ pale yellow and bean-shaped, continuous with spermoviduct, a long and convoluted tubular organ (Figure 3A); female portion (uterine portion containing seminal groove) of spermoviduct transversely sacculated; distally, spermoviduct splitting into free oviduct and vas deferens; free oviduct with internal thin longitudinal folds for its entire length; vas deferens, a long thin duct, running to distal portion of genitalia where it turns toward proximal portion of penial complex, inserting in proximal region of epiphallus; duct of bursa copulatrix continuous with vagina with free oviduct inserted in an angle with vagina; bursa copulatrix duct wide in its distal portion, sac swollen and elongated; a thin blind diverticulum arising at angle formed by free oviduct and bursa copulatrix duct (Figure 3B); diverticulum running parallel to bursa, attached by tissue to it, and reaching middle zone of spermoviduct with its blind extremity, internally, distal portion of bursa copulatrix duct with same sculpture as proximal portion of vagina, consisting of thin parallel folds;

vagina short ($\frac{1}{4}$ of penis length) ending in genital atrium at same level as penis; penial complex composed of flagellum, epiphallus, and penis; flagellum thick, cylindrical, and short, internally a thick pilaster continuous with proximal portion of epiphallus; epiphallus about three times as long as flagellum with same diameter, reflected over proximal portion of penis and attached to penis sheath by tissue; penis thicker in diameter, about three times as long as epiphallus, internally with a thick pilaster composed of lamellae in zigzag pattern; rest of the penis sculpture consisting of thin, undulating transverse ridges; distal portion of penis with thin longitudinal folds; penis sheath muscular, overlapping entire penis length (Figures 3D, E); atrium with same internal sculpture as distal portion of penis.

Digestive system (Figure 4): The arrangement of the digestive tract follows the general patterns described for *Stylommatophora* (Tillier, 1989). Jaw arcuate, with 12 thin parallel ribs well marked (Figure 4A), transverse fine striae present on its entire surface, especially marked between ribs, less marked perpendicular lines giving a reticulate impression on the rib surface and marginal plates (Figure 4B); radula thin and long ($33 + 1 + 33 \times 120$); central tooth with tricuspid crown, high mesocone, two times longer than ectocones, laterals bicuspid with high mesocone (Figures 4C, D), marginals tricuspid to multicuspid with ectocones and an endocone, mesocone progressively reduced to the margins of the radula (Figures 4E, F), basal plate of marginal teeth compared to central tooth reduced in length but not in width; buccal mass muscular, round to ovoid; esophagus opening dorsally from buccal mass and progressively increasing in size, forming an esophageal crop, its wall presenting longitudinal thin, deep ridges; two long salivary glands appressed to esophagus, with their main ducts opening into buccal cavity on each side of the esophageal opening; distal portion of glandular bodies joining together over esophageal crop; gastric crop cylindrical; stomach receiving posterior and anterior ducts of digestive gland; two internal typhlosoles arising from point of insertion of ducts of digestive gland, typhlosoles running into proximal intestine, the one beginning at opening of anterior duct longer; intestine running along columellar side of visceral mass turning down under anterior portion of gastric crop and then forming periaortic intestinal loop; rectum following intestine running parallel to pulmonary roof and ending at mantle collar.

Central nervous system (Figure 2B): Entirely contained in pedal cavity, composed of two dorsal ganglia and a ventral chain; both dorsal ganglia connected by a short cerebral commissure and located above esophagus; cerebropleural connectives running obliquely backward connecting dorsal ganglia to ventral chain, forming a ring around esophagus; ventral chain composed of right and left parietals and a visceral ganglion; visceral ganglion

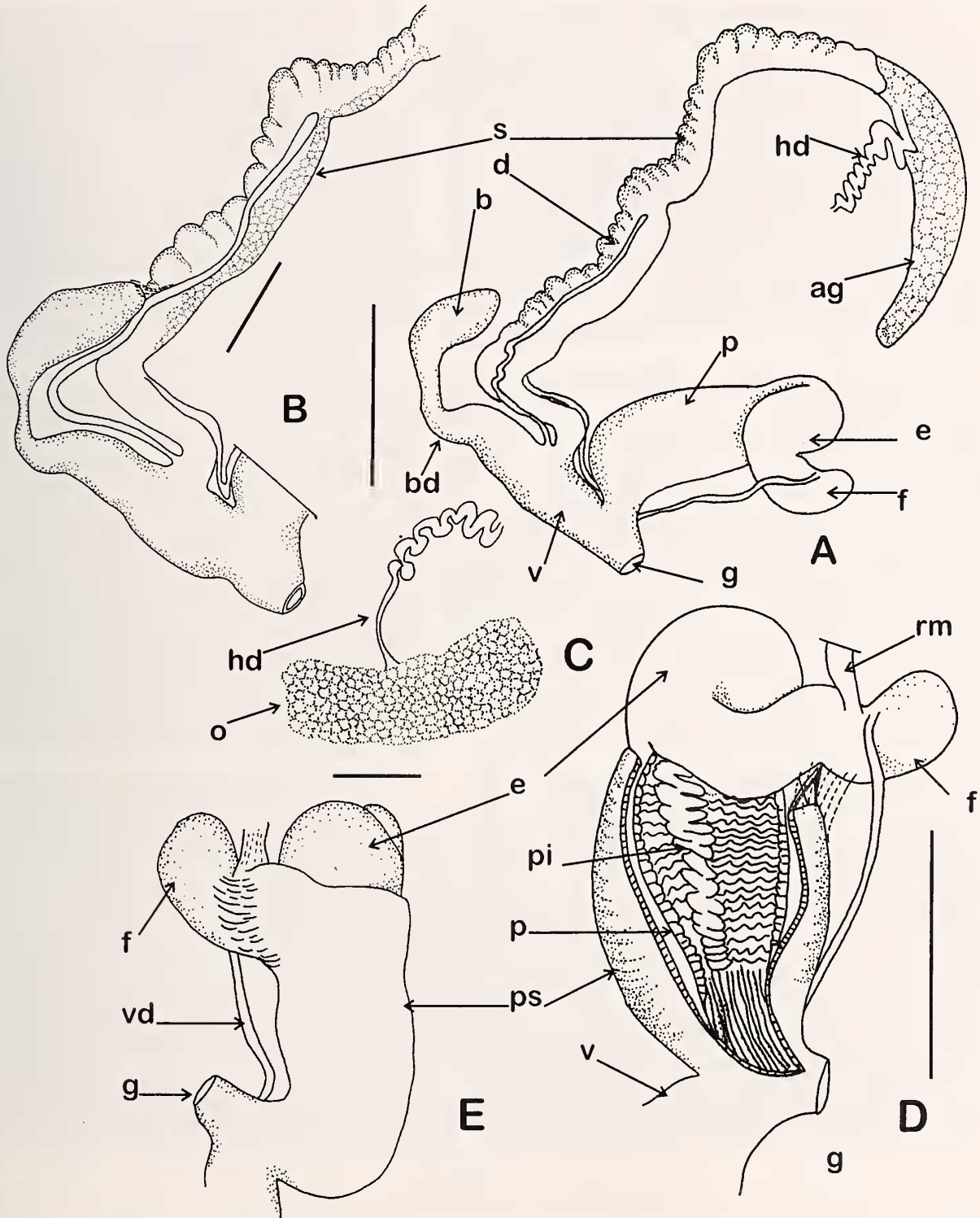


Figure 3. *S. chicomendesi* Cuezco & Fernández, sp. nov. (Paratype FML 14174). A. Dorsal view of the reproductive system, scale bar = 5 mm. B. Detail of female terminal genitalia, scale bar = 2 mm. C. Ovotestis, scale bar = 2 mm. D. Penial complex with penis wall and sheath longitudinally cut, scale bar = 5 mm. E. Penial complex in ventral view. Abbreviations: ag, albumen gland; b, bursa copulatrix; bd, bursa copulatrix duct; d, diverticulum; e, epiphallus; f, flagellum; g, genital orifice; hd, hermaphroditic duct; o, ovotestis; p, penis; pi, pilaster; ps, penial sheath; rm, penial retractor muscle; v, vagina; vd, vas deferens.

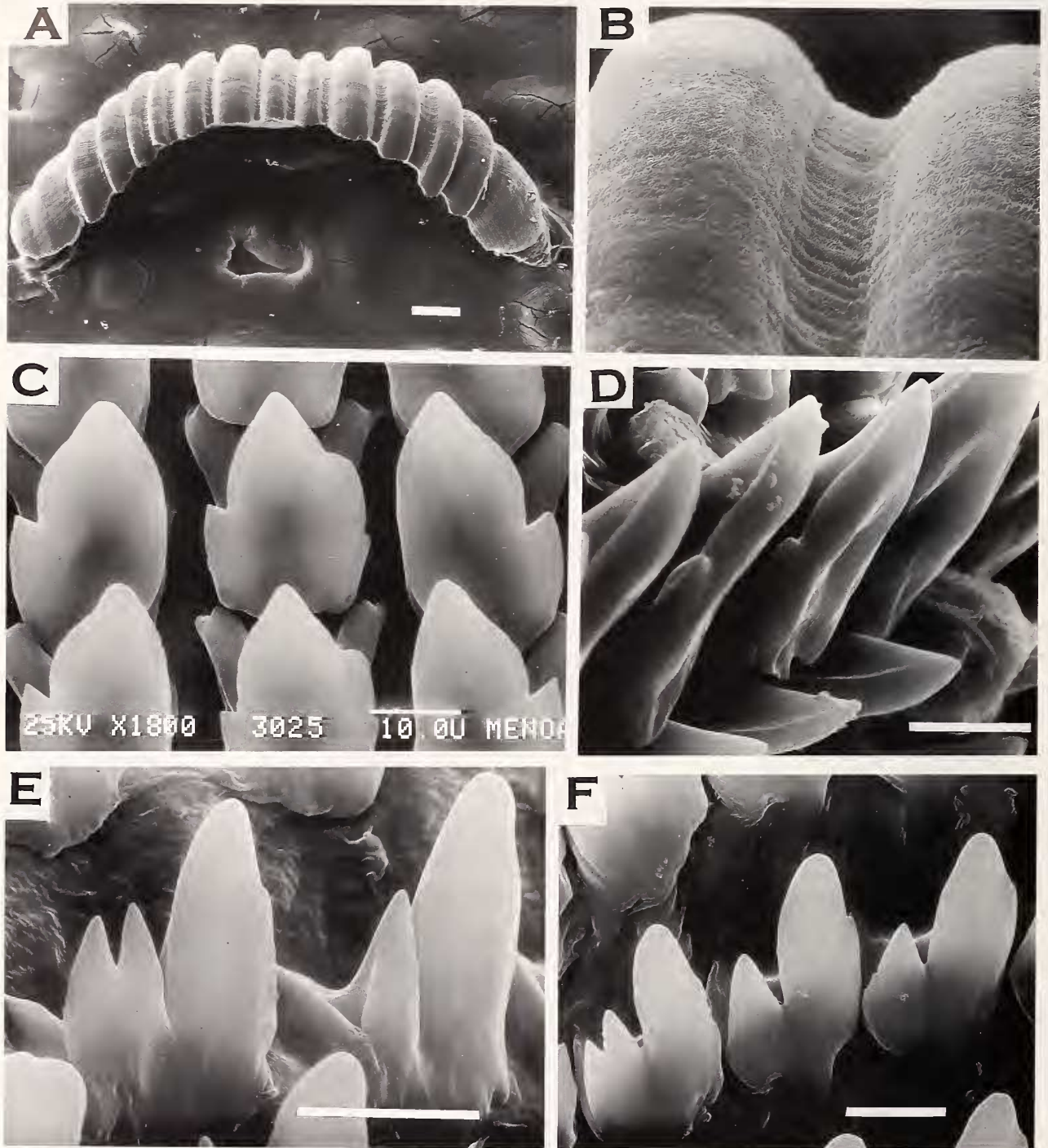


Figure 4. *S. chicomendesi* Cuezco & Fernández, sp. nov. (Paratype FML 14174). A. Jaw, scale bar = 100 μm . B. Detail of the sculpture of dorsal surface, scale bar = 10 μm . C. Radula: central and first lateral teeth in dorsal view, scale bar = 10 μm . D. Detail of central tooth and lateral teeth, scale bar = 10 μm . E. Transition from lateral #23 to first marginal teeth, scale bar = 10 μm . F. Marginal teeth in erected position, scale bar = 10 μm .

Table 2

Comparative characters between *S. chicomendesi* and the other species of the genus with known anatomy.

Characters	<i>Solaropsis chicomendesi</i> , sp.nov.	<i>Solaropsis heliaca</i> (d'Orbigny, 1835)	<i>Solaropsis brasilitana</i> (Deshayes, 1832)	<i>Solaropsis angulifera</i> Haas, 1955	<i>Solaropsis undata</i> (Lightfoot, 1786)	<i>Solaropsis marmatensis</i> (Pfeiffer, 1854)	<i>Solaropsis nubeculata</i> (Deshayes, 1831)	<i>Solaropsis gibboni</i> (Pfeiffer, 1846)
Shell	Convex, thin, fragile, whorls	Subcarinate, thin, 5-6 whorls	Convex, solid, 5 whorls	Convex, 4½ whorls	Convex, solid, 6 whorls	Convex, fragile, 4-4½ whorls	Convex, 4½-5 whorls	Carinated, solid.
Shell size (in mm)	Diam. maj: 20-21 Diam. min: 17-18 Alt.: 8-9	Diam. maj: 29-37 Alt. 12-16	Diam. maj: 33-42 Diam. min: 27-34 Alt.: 17-19	Diam. Maj: 29.6 Diam. min: 25 Alt: 14.7	Diam. maj: 40-48 Dim. min: 35-40 Alt.: 22-25	Diam. maj: 11-12 Diam. min. 9-10 Alt.: 6	Diam. maj: 18.4 Alt.: 11.2	Diam. maj: 60-63 Diam. min: 51-54 Alt.: 27-28
Shell sculpture	Granules and peripheral oblique ribs, scattered hairs	Granules and zigzag ridges	Regularly granulate, arranged into oblique rows	Regularly granulate, scattered peripheral hairs	Wavy, undulated rugae, granulated	Minutely granulate Covered with short hairs	Granulated	Coarsely obliquely striate, not granulated
Shell aperture	Ventral, subquadrate, peristome thin, slightly reflexed	Oblique, broader than high, peristome wide, reflexed	Oblong-lunar, slightly oblique, peristome narrowly expanded	Semilunar with slightly expanded peristome	Broad-lunar, oblique, peristome white, reflexed all around	Rounded-lunar, little oblique, peristome narrowly expanded	Semilunar, wider than high, peristome thin, slightly expanded	Broad-lunar, oblique, peristome reflexed all around
Shell spire	Moderately elevated	Moderately elevated	Depressed, apex obtuse	Depressed, nearly flat, apex obtuse	Elevated	Near flat	Moderately elevated	Elevated, obtuse
Kidney length	90% of pulmonary roof length	90% of pulmonary roof length	70-80% of pulmonary roof length	70-80% of pulmonary roof length	Half the length of the pulmonary roof	80-90% of pulmonary roof length	80-90% of pulmonary roof length	25% of the pulmonary roof length
Secondary ureter	Closed	Closed	Closed	Closed	Open all along rectum	Closed	Closed	Open all along rectum length
Pulmonary roof	Extends beyond top of kidney	Extends beyond top of kidney	Extends beyond top of kidney	Extends beyond top of kidney	Extends beyond top of kidney	Not extending beyond top of kidney	Not extending beyond top of kidney	Extending beyond top of kidney
Penis-epiphallus	Reflexed	Reflexed	Not reflexed	Epiphallus reflexed over itself	Not reflexed ?	Not reflexed ?	Not reflexed	Not reflexed
Penial appendix	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present
Length of bursa copulatrix	Less than half spermoviduct length	Extends to base of spermoviduct	Long, extends all spermoviduct length	Less than half spermoviduct length	Long, extends almost all spermoviduct length	Less than half the spermoviduct length	Less than half the spermoviduct length	Long, as long as spermoviduct
Length of diverticulum	Half spermoviduct length	Same length as bursa copulatrix sac	Half the bursa copulatrix length	Long, same length as spermoviduct	Short projection	Half the length of the bursa copulatrix	Half the length of the bursa copulatrix	¼ of the bursa copulatrix length
Verge	Absent	Absent	Absent	Present	Present	Present	?	Absent

Table 2
Continued.

	<i>Solaropsis chicomendesi</i> , sp. nov.	<i>Solaropsis heliaca</i> (d'Orbigny, 1835)	<i>Solaropsis brasilitana</i> (Deshayes, 1832)	<i>Solaropsis angulifera</i> Haas, 1955	<i>Solaropsis marmatensis</i> (Pfeiffer, 1854)	<i>Solaropsis nuberculata</i> (Deshayes, 1831)	<i>Solaropsis gibboni</i> (Pfeiffer, 1846)
Characters							
Penis sculpture	Pilaster and transverse undulating folds	Proximal portion with zigzag ridges, distal with straight ridges	Longitudinal ridges	Pilaster and longitudinal undulating folds	Proximal portion with pilasters, distal portion with thin longitudinal folds	?	Proximal portion with pilasters, distal portion with longitudinal ridges in zigzag
Female portion of the sperm-oviduct	Transversally plicated	Longitudinally plicated	Longitudinally plicated	Transversal sacculations	Transversally sacculated	?	Longitudinally folded
Flagellum	Short and thick	Short and thick	Thin and long	Short with lateral projections	Thin, medium length	Thin, medium length	Thick and short
Free oviduct	Inserting in vagina in an angle, bursa copulatrix duct continuous with vagina	Continuous with vagina, bursa copulatrix duct inserts in an angle	?	Continuous with vagina, bursa inserts in an angle	Continuous with vagina, bursa inserts in an angle	Continuous with vagina	Continuous with vagina

fused with left parietal ganglion; all other ganglia of ventral chain in contact but not fused.

Etymology: This species is named to honor Francisco Alves Mendes, known as Chico Mendes, the brave defender of the tropical rainforest and its inhabitants.

DISCUSSION

Solaropsis is a poorly known genus of the neotropical malacological fauna. Most of the species comprising the genus (see Richardson, 1985) were described on the basis of shell characters. Tillier (1980) was the first to attempt to define *Solaropsis* using characters from the pallial and genital system. Later, the diagnosis for the Solaropsidae proposed by Nordsieck (1986) was based on three main characters: diverticulum present (bursa copulatrix), male duct with penial appendix, and forked penial muscle retractor. While these characters are present in the type species of *Solaropsis*, only the presence of a diverticulum in the bursa copulatrix is a constant character in the rest of species with known anatomy in the genus. Also, *Solaropsis* is morphologically similar to *Labyrinthus* and *Isomeria* in shell sculpture, the presence of a reflexed penis-epiphallus, the length and morphology of the kidney, and the length of the typhlosole in the digestive system. For these reasons, *Solaropsis* should be classified within the Camaenidae, at least until additional anatomical information is available, and a phylogenetic analysis of the Camaenidae is carried out, supporting its inclusion or exclusion from that family.

Three characters that are common to all the species of *Solaropsis* anatomically studied are: (1) the presence of a bifurcated bursa copulatrix duct; (2) a spermoviduct groove extending through the free oviduct; and (3) the long typhlosole in the intestine. However, only a cladistic analysis of the genus can determine if those characters are indeed true synapomorphies of the genus.

Different anatomic characters of *S. chicomendesi* were compared (Table 2) with species with studied anatomy except for *S. feisthameli*, which was poorly described by Von Ihering (1900).

With regard to its shell, *S. chicomeudesi* does not present the deep constriction on the peripheral portion of the body whorl, which is often present in some specimens of the type species, *S. undata*. *S. chicomendesi* shares a similar pattern of shell sculpture with most of the *Solaropsis* described except for *S. gibboni* where the granules of the shell are absent.

The pallial system is similar in all *Solaropsis* studied, except for the kidney length which is less than half the pulmonary roof length in *S. gibboni* and *S. undata*; the other species show a very long kidney, about 80% the length of the pulmonary roof length. The secondary ureter is open only in *S. undata* and *S. gibboni*, being closed until the distal portion of the rectum in the other species.

The radula is similar in all species studied and does

not seem to be an important character in distinguishing *Solaropsis* species. The jaw is ribbed in all species and particularly thin in *S. chicomendesi* and *S. feisthameli*.

With regard to the reproductive system of *S. chicomendesi*, the reflexed penis-epiphallus is present in some species of *Solaropsis* such as *S. angulifera*, *S. heliaca*, and *S. chicomendesi*, although some differences exist among them. In the case of *S. angulifera*, the epiphallus is reflexed over itself, whereas in the other two, the epiphallus is reflexed over the penis. The ovotestis in all species studied is formed by a unique mass of round to oval acini. As in most American Camaenidae the FPSC in *S. chicomeudesi* is not evident and is probably absent as in the rest of *Solaropsis* species. The presence of a diverticulum in the bursa copulatrix is a character constant in the genus. In *S. chicomendesi* the free oviduct inserts into the vagina in an angle while the vagina is continuous with the bursa copulatrix duct. This situation is very peculiar since in the majority of Stylommatophoran snails the free oviduct is continuous with the vagina, whereas the bursa copulatrix duct usually inserts in an angle in the vagina. Only in *Labyrinthus* and *Isomeria* species has a similar disposition of the organs and ducts been described (Solem, 1966; Cuzzo, in press). In the rest of *Solaropsis* species the free oviduct is continuous with the vagina.

Solaropsis is probably more related to the Camaenidae than to any other Stylommatophoran family because it shows several morphological similarities with the other continental Camaenidae: *Labyrinthus* and *Isomeria*. However, only through a cladistic analysis will it be possible to test this hypothesis. The three mentioned genera are poorly known so it is urgent that new collections of live material be carried out, as well as more anatomical studies to permit generic systematic revisions. This goal can only be realized through support for training in taxonomy of young local malacologists in different countries where the malacological fauna is so poorly known.

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